# Status of the Yemilab operation

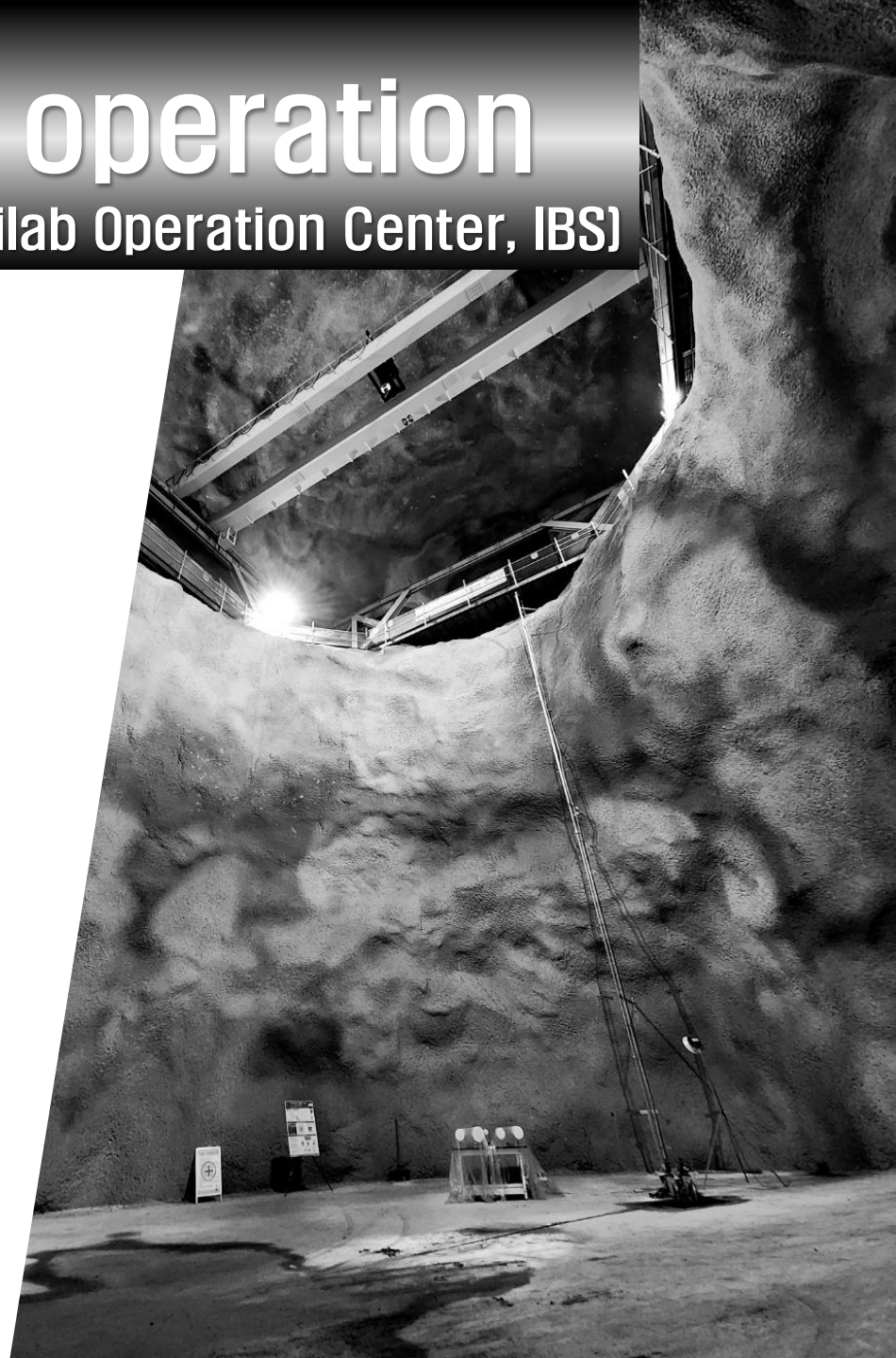
Jungho So (Yemilab Operation Center, IBS)

Yemilab

EST. 2022

Less Muon

Better Flavor

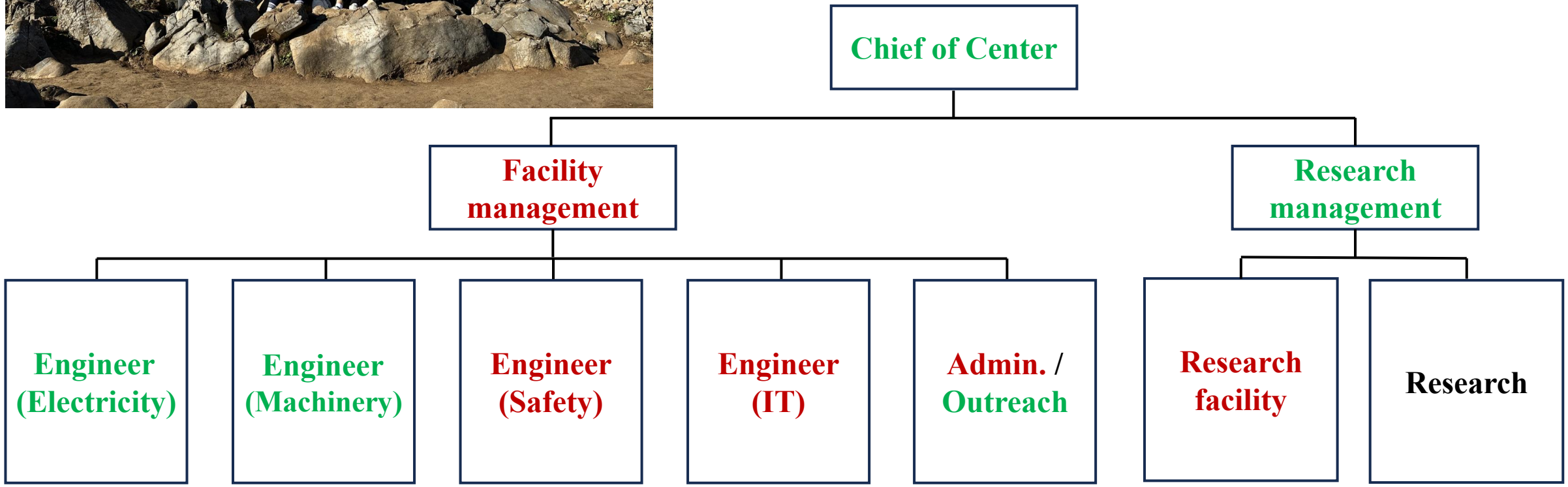


XIX TAUP, Xichang Qionghai Hotel (2025)

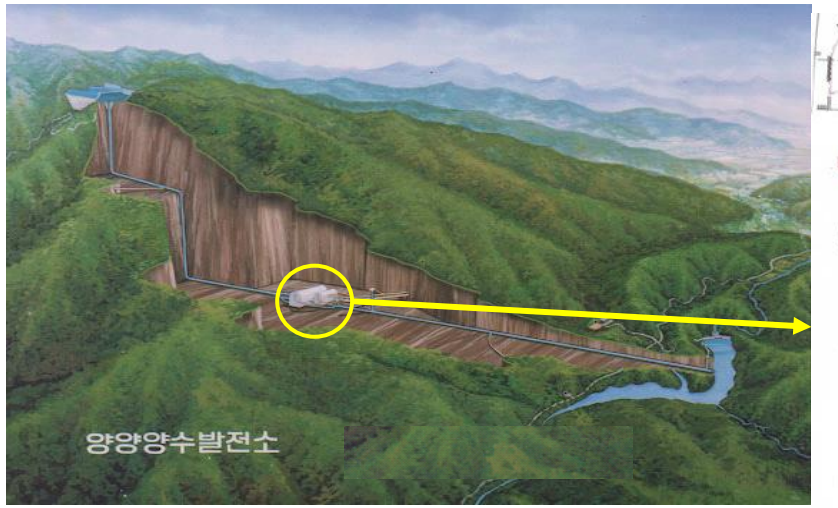
# New organization of the Yemilab

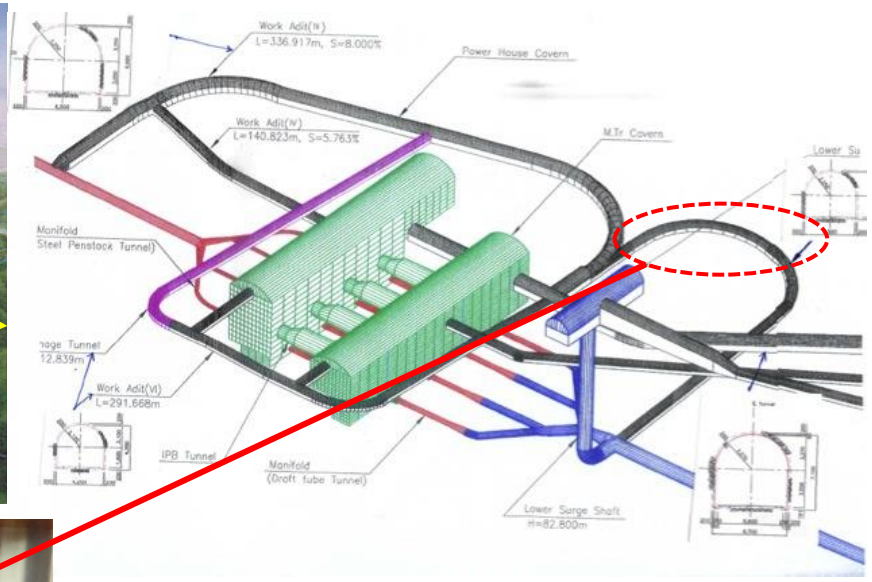

Yemilab Operation Center since March 2025!

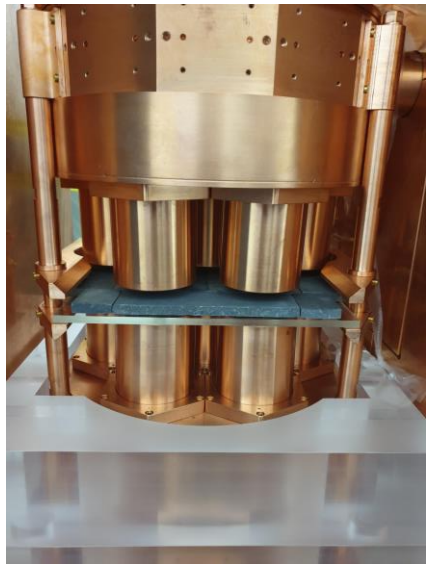
- **Staffs on Yemilab operation center : 4 people**
- **Staffs on Center for Underground Physics : 5 people**



# 20 years history
# (Yangyang underground lab, Y2L)

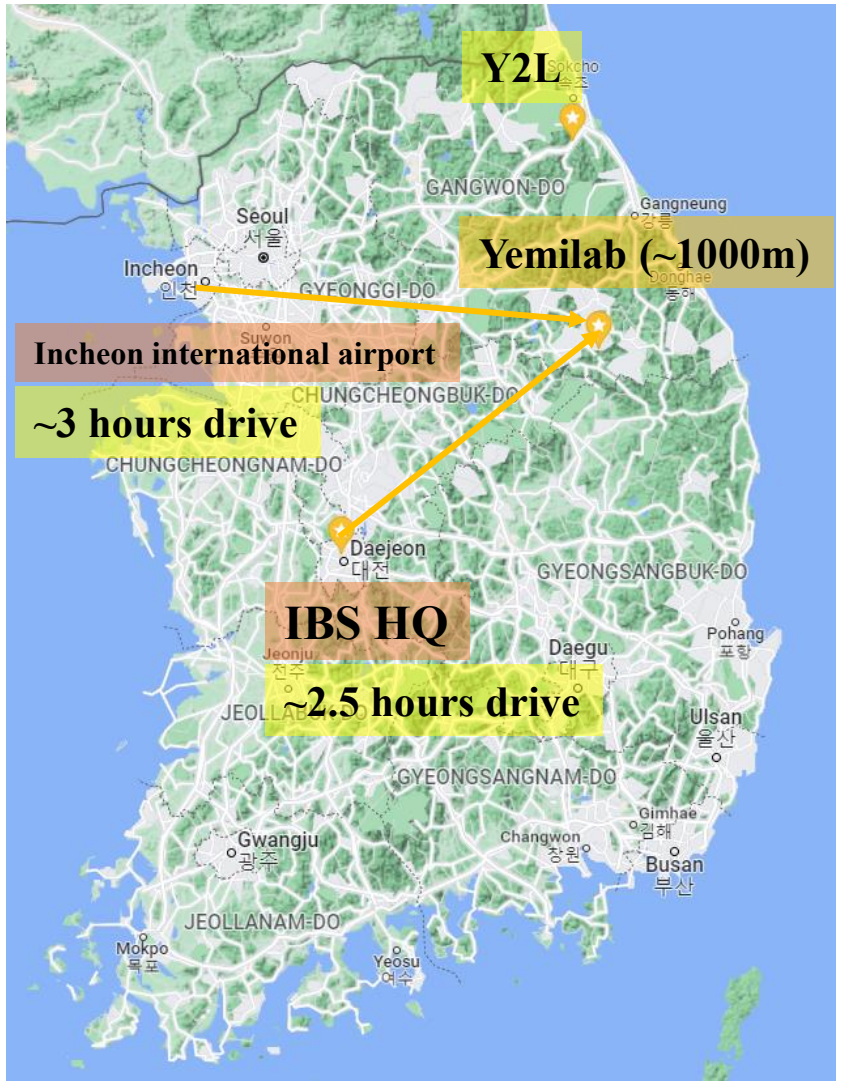



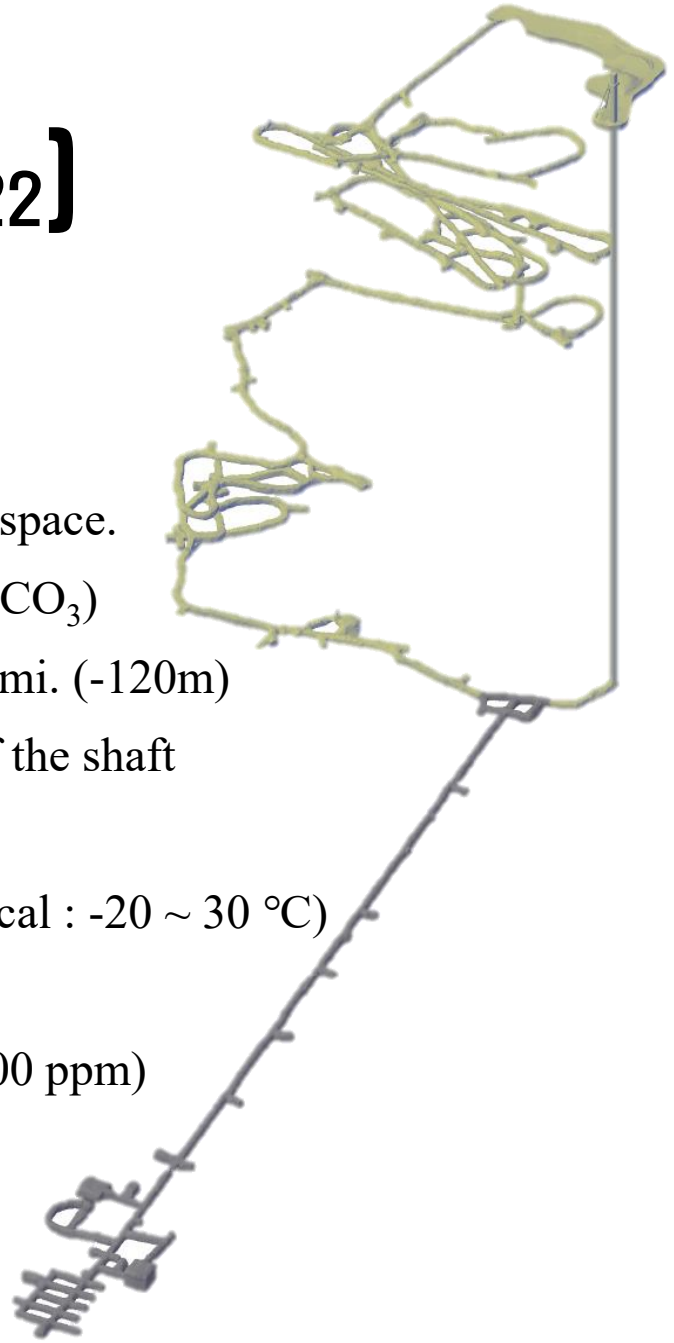
Y2L phase 2 (A5 tunnel added)

- Since 2013~ (IBS funding)
- 100m$^2$ + 200m$^2$ area
- Radon Reduction System
  - ATEKO → dismissed
- COSINE → Yemilab
- AMoRE → Yemilab
- 14ch array HPGe Y2L ~ 2026

# New history (Yemilab, since Oct. 2022)



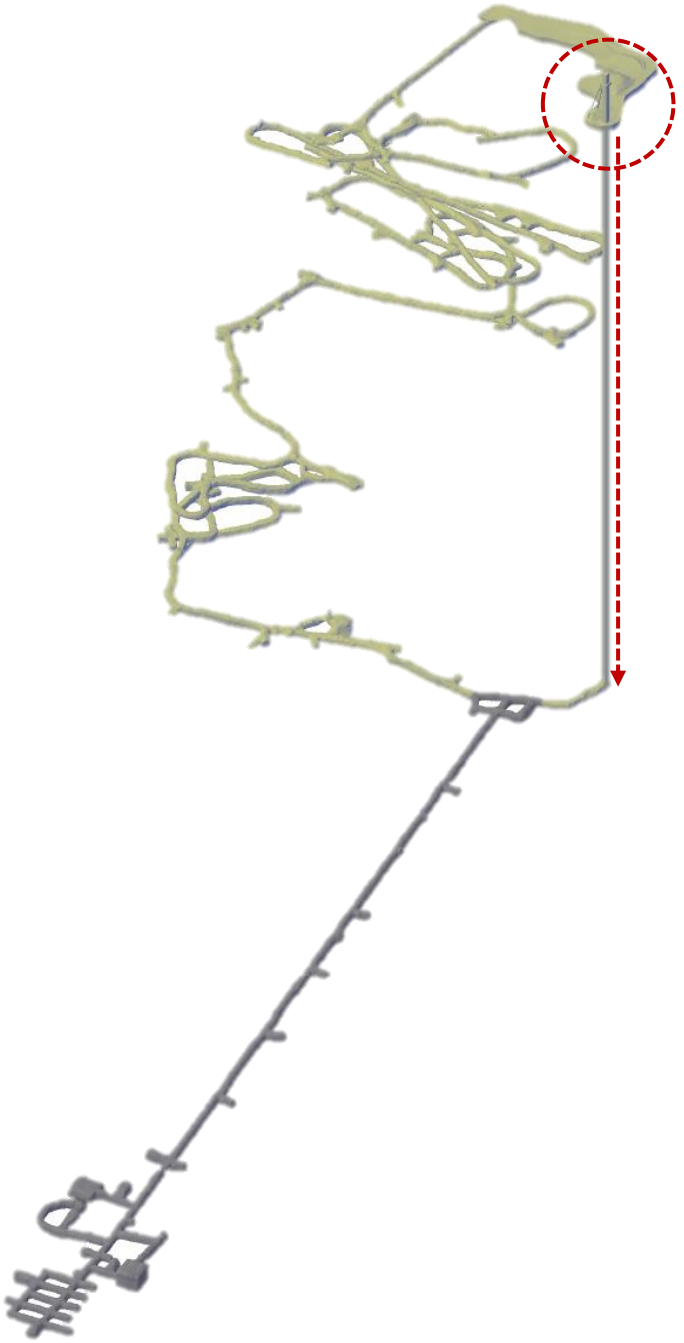

- Total area : 10,000 $m^2$ including 3,000 $m^2$ Lab. space.
- Rock composition : Limestone ($CaCO_3$ and $MgCO_3$)
- Overburden : 1009m from the top of the Mt. Yemi. (-120m)
- Air circulation: 39,000 $m^3$/hour from the end of the shaft
- Electricity : 2MW (UPS 380 kW)
- Temperature : 25 ~ 29 ℃ at AMoRE cavern (local : -20 ~ 30 ℃)
- Humidity : 25 ~ 60 % at AMoRE cavern
- Airborne chemical : CO (< 10 ppm), $CO_2$(<1,500 ppm)



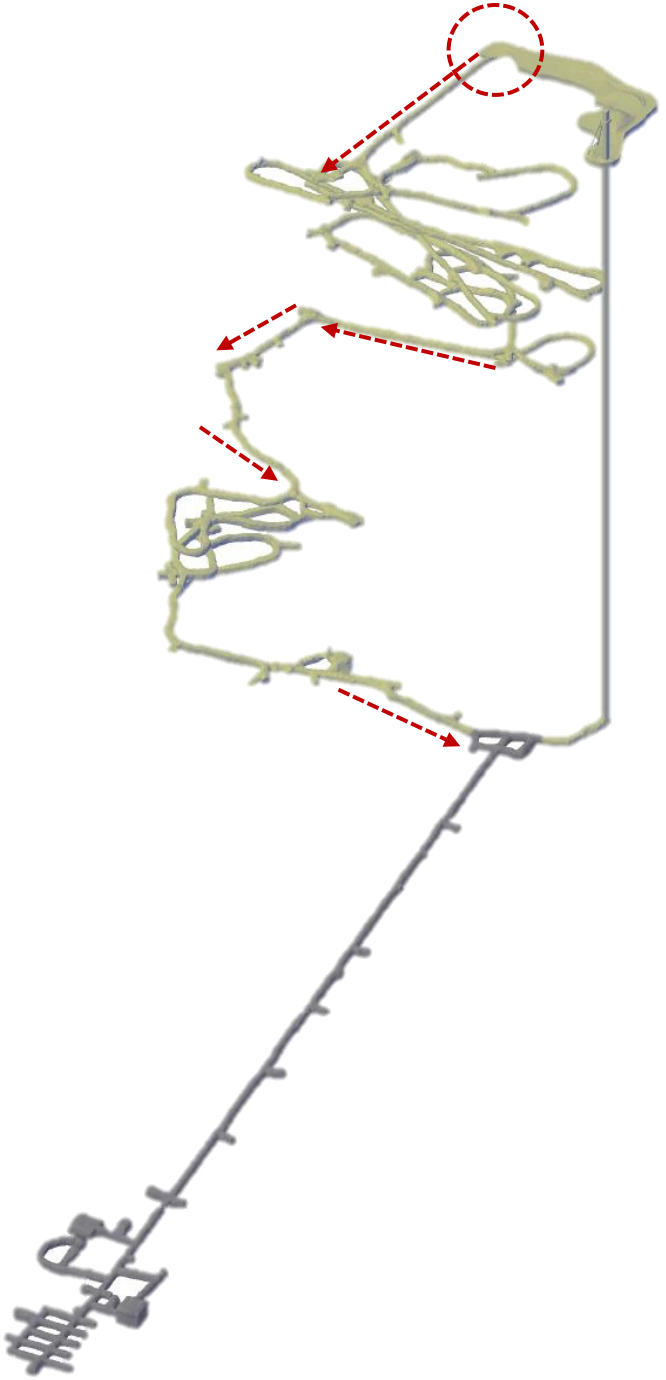
# Access to Yemilab (Cage)

**Cage for people**

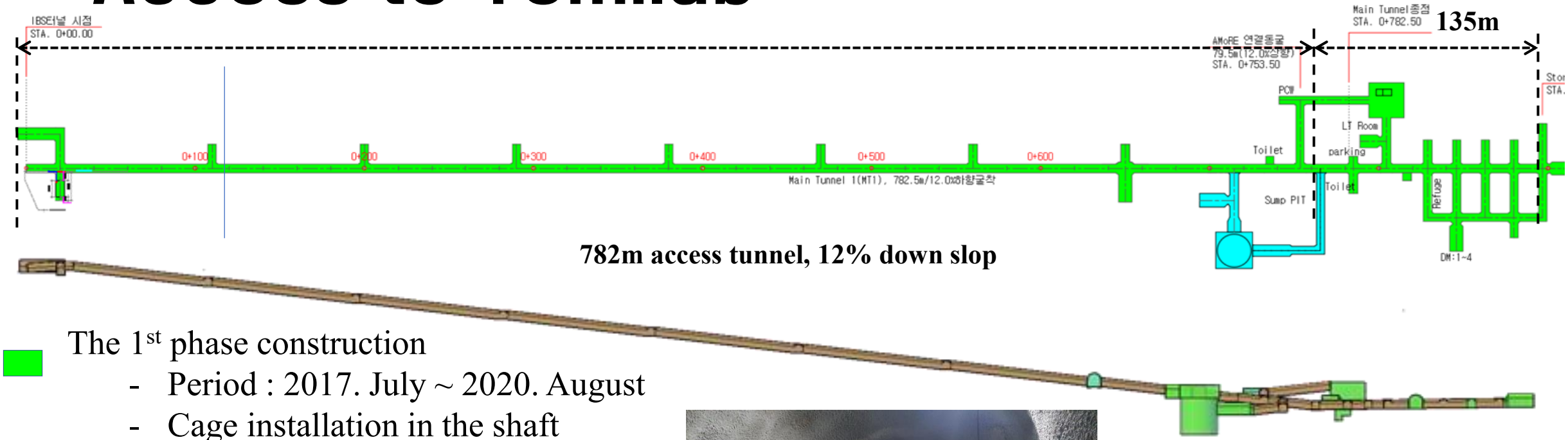
- Manufactured by SIEMAG
- Capacity : ~ 8 people, 1.5 tons
- Speed : 4 m/sec, 2.5 min
- 600m length of shaft



# Access to Yemilab (Rampway)

# Access to Yemilab




**782m access tunnel, 12% down slop**

The 1st phase construction
- Period : 2017. July ~ 2020. August
- Cage installation in the shaft
- 1st phase Excavation : 2000m$^2$

The 2nd phase construction
- Period : 2021. May ~ 2022. July
- 2nd phase excavation : 1000m$^2$
- Electricity and machinery
- Ground office renovation

# Infrastructures



- Full mobile and ethernet communication
- Rnless air supply system (for summer season)
- Radon reduction system (50 $m^3$/h, goal: 1/1,000 reduction)
  - 200$m^3$/h RRS has been planned at the end of 2026.


- LN2 generators for cryostats and HPGe
- Dust proof doors
- Electric vehicles for dust proof area
- Cranes for the large caverns (for large construction)
- Refuge (40 people for 72 hours, Dried food, water, air, UPS and so on)
- **Toilets**

# Radon Reduction System (Made in Korea)

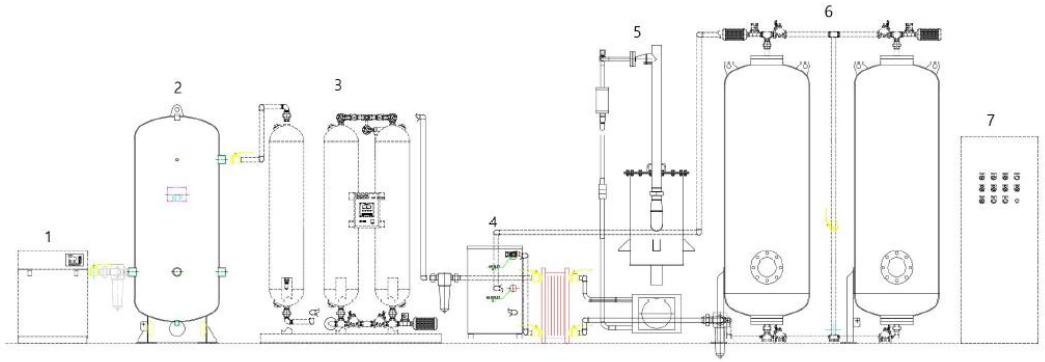
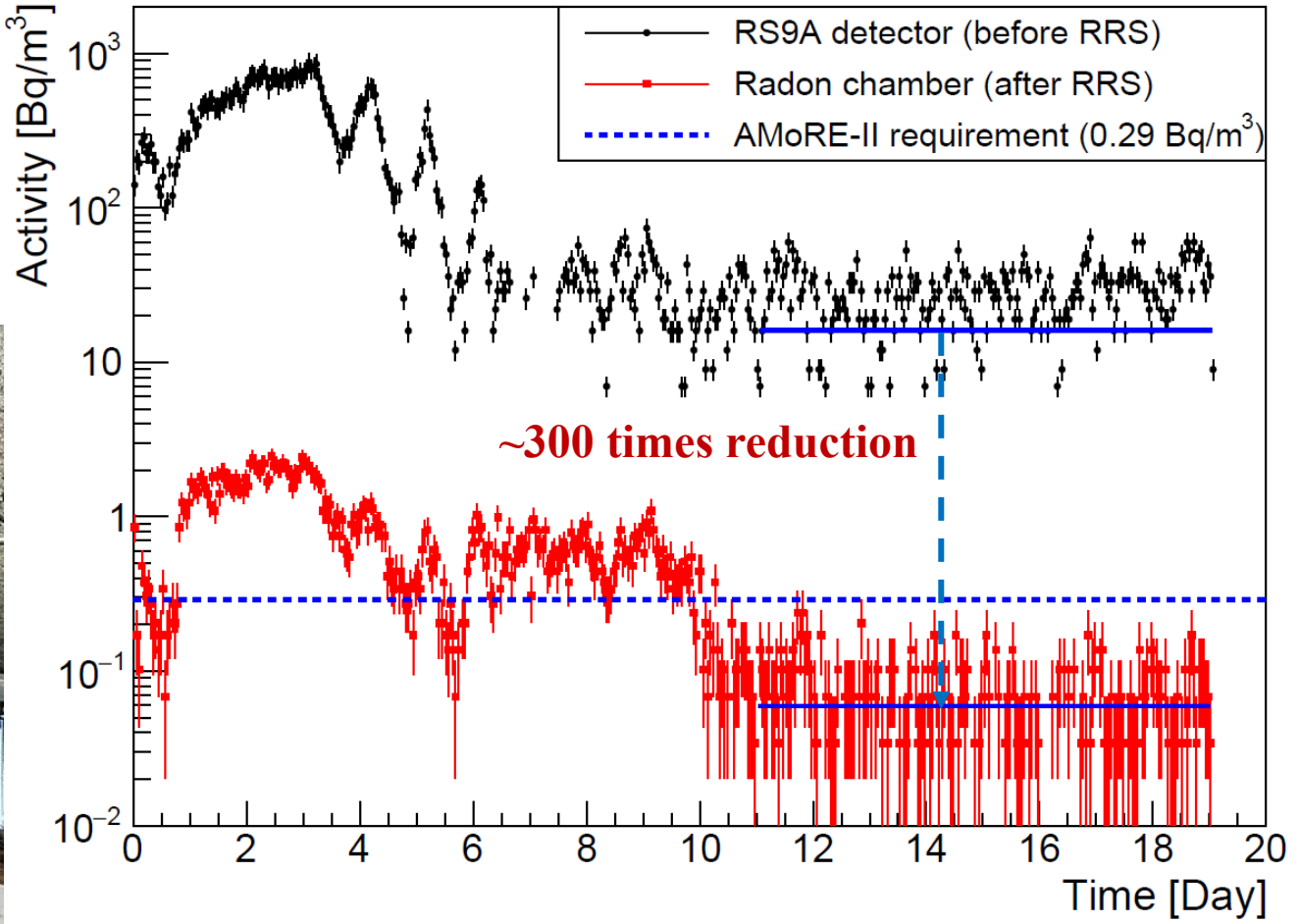


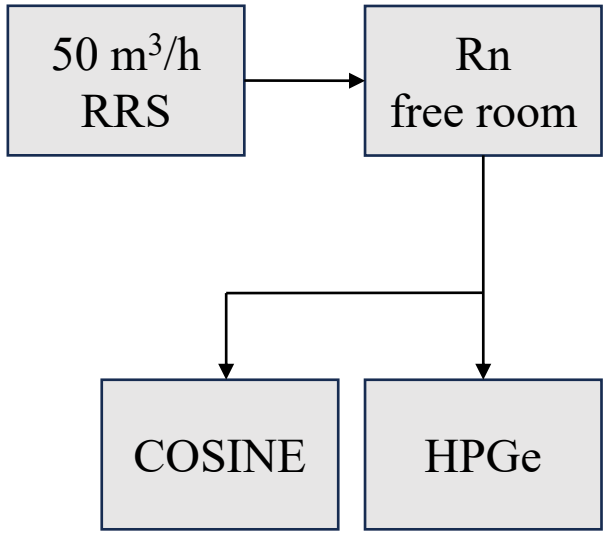

**Figure 3.** The layout of the custom-made Radon Reduction System. 1: Compressor, 2: Receiver tank, 3: Absorption dryer, 4: Air chiller, 5: Heater and HEPA filter units, 6: Active charcoal tanks, and 7: Control panel.

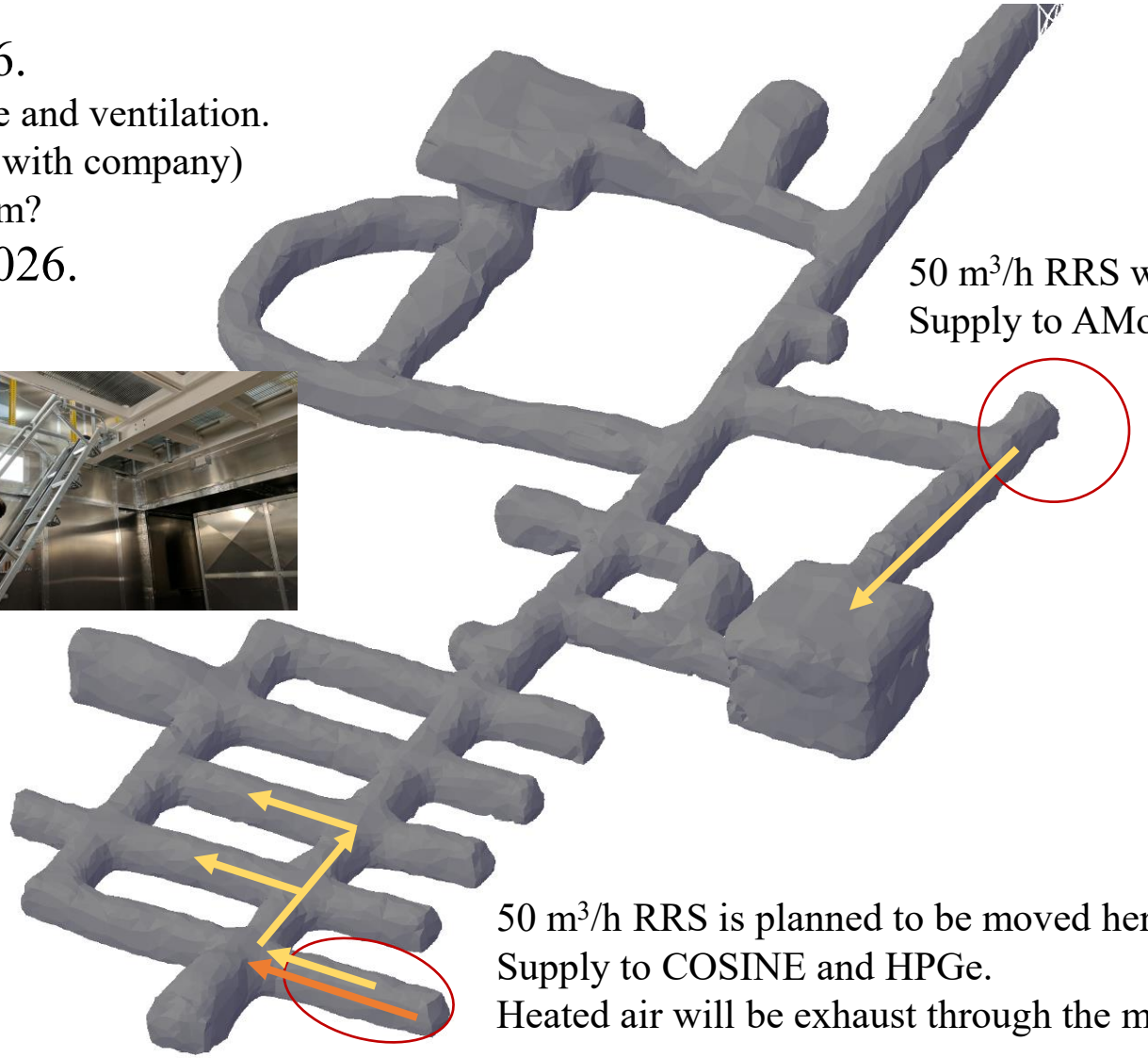


# New 200 $m^3/h$ RRS system (water cooling)

- Budget has been prepared in 2026.
  - Further budget for new STS pipeline and ventilation.
  - May include in the budget. (discuss with company)
  - If the budget is enough, Rn free room?
- Target installation at the end of 2026.
  - No more air chiller, PCW chilling.

**Conceptual idea**



50 $m^3/h$ RRS will be replaced to 200 $m^3/h$.
Supply to AMoRE detector room fully.

50 $m^3/h$ RRS is planned to be moved here.
Supply to COSINE and HPGe.
Heated air will be exhaust through the main ventilation.

# Raspberry Pi based monitoring system

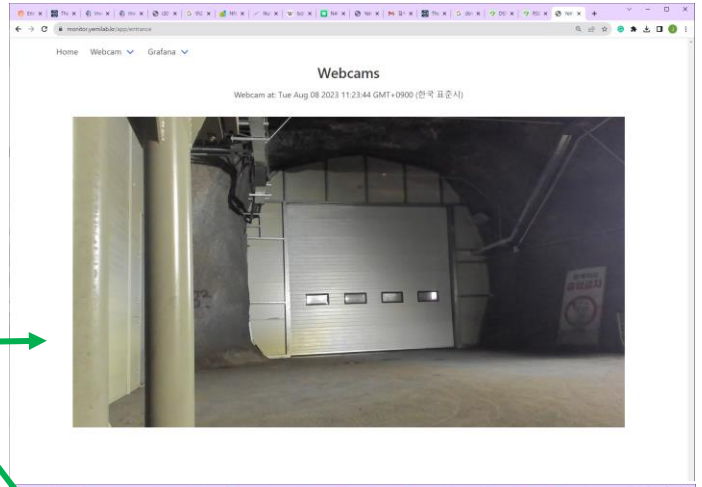
**UA10**
Calibration software
Temp. : -40 ~ 80 ℃
Humidity : 5 ~ 95 %

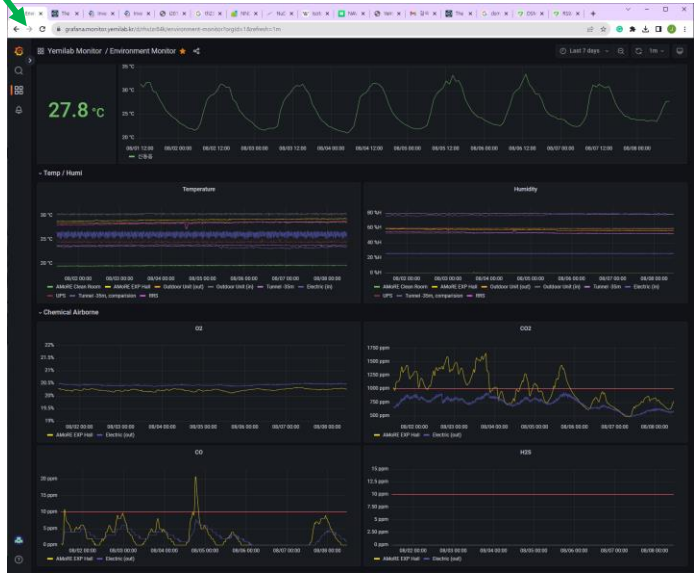
**DSM101**
PM1.0 / PM2.5 / PM10
1~1,000 $\mu g/m^3$

USB connection

**Raspberry Pi-3**

**Ethernet**



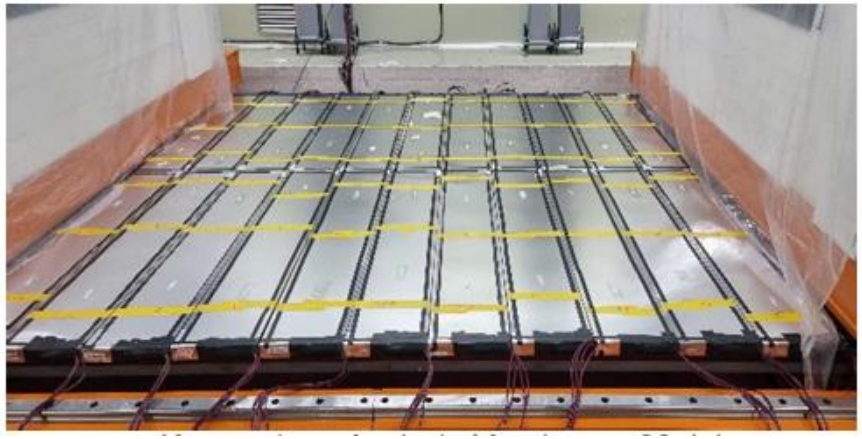


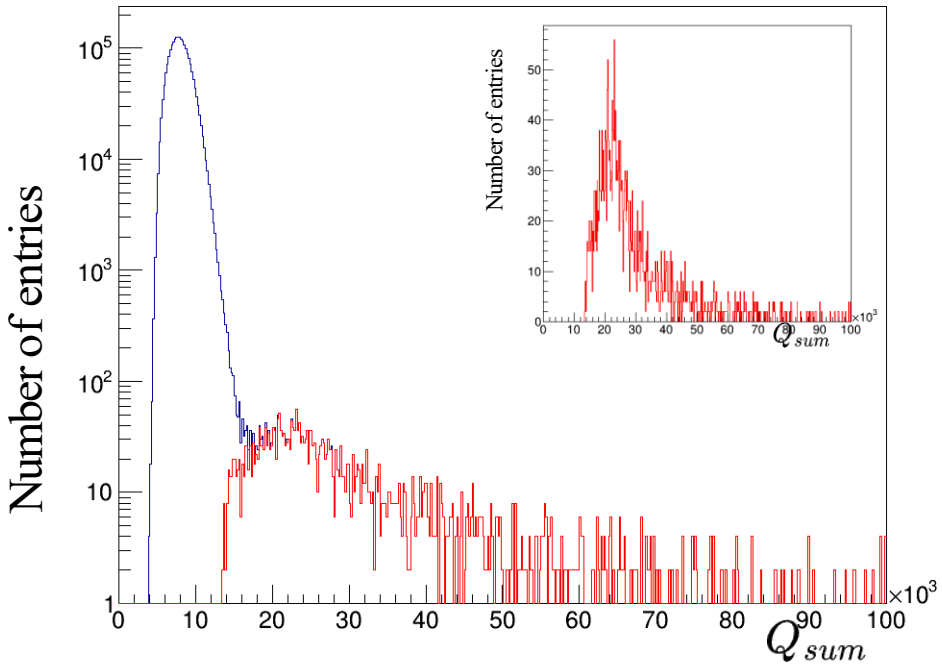
**UA58-KFG-U**
CO (~ 1,000 ppm)
$CO_2$ (400 ~ 10,000 ppm)
$O_2$ (0 ~ 25%)
$H_2S$ (0 ~100 ppm)


**RS9A**
7 ~ 3700 Bq/$m^3$
±15% accuracy

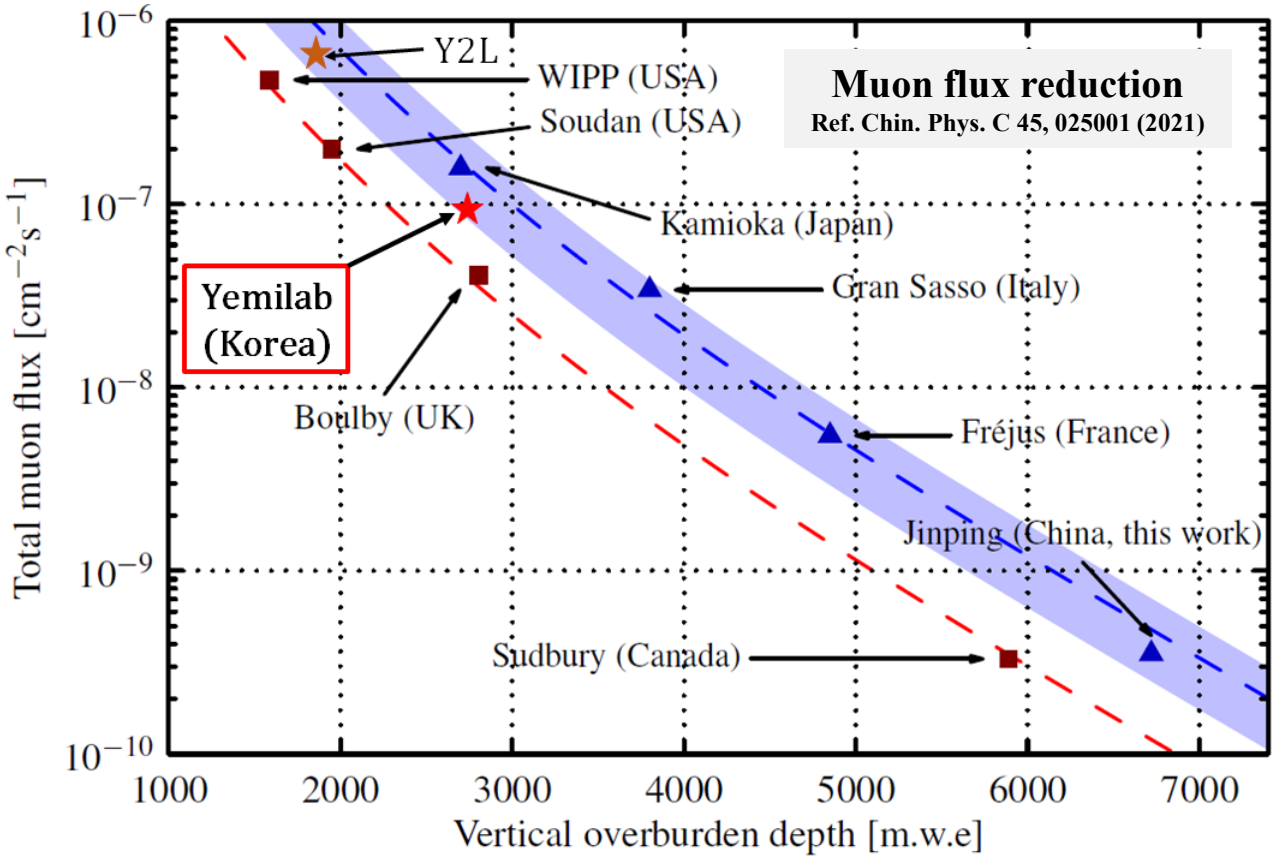
**Webcam**
1 picture / min

# Muon mitigation



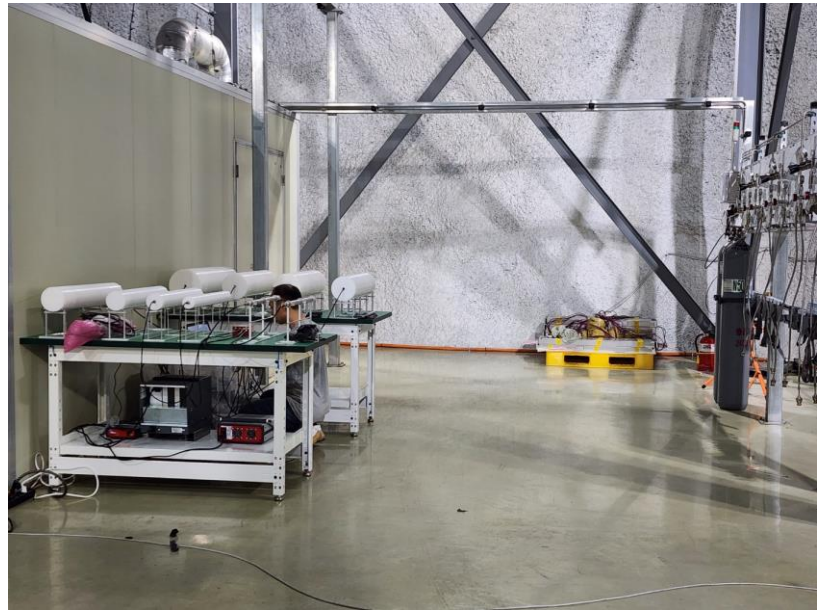



- **22 Plastic scintillator panels (1680 × 310 × 61 mm³ each)**
- **Preliminary muon rate at AMoRE cavern: 8.8 × 10⁻⁸ $\mu$/cm² sec**
  - Y2L COSINE: 3.8 × 10⁻⁷ $\mu$/cm² sec

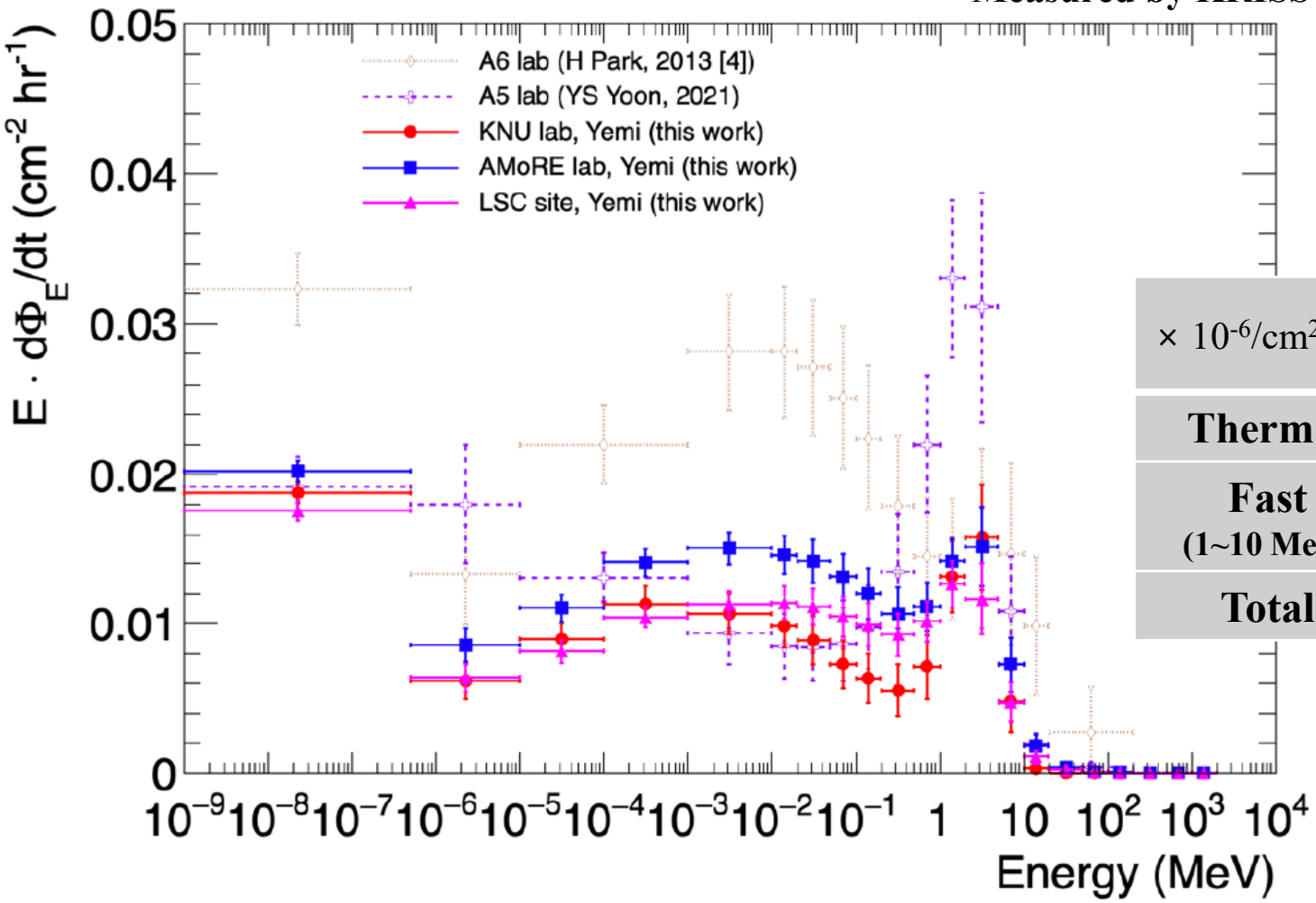


# Neutron flux

**$^3$He detectors with different thickness of PE moderators**



**Measured by KRISS**

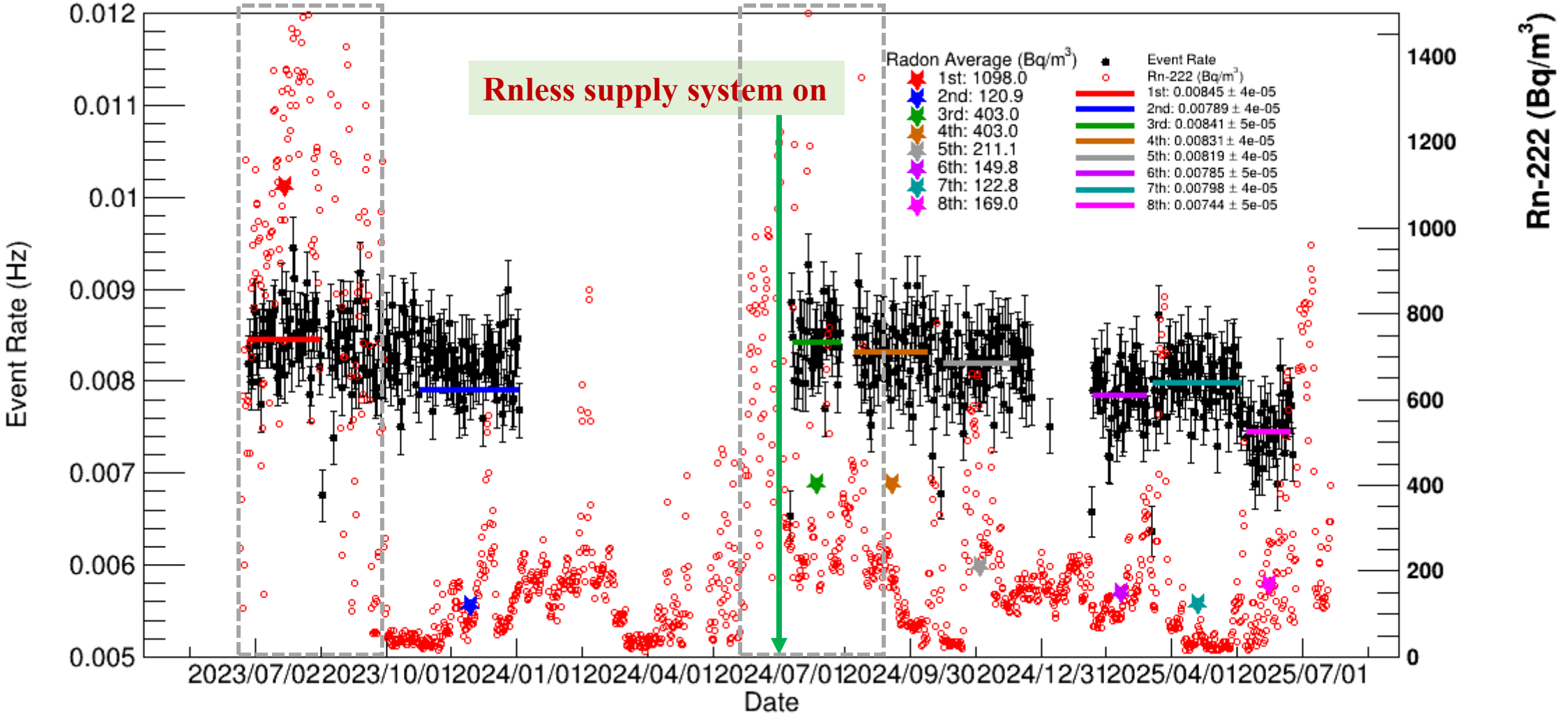



| × $10^{-6}$/cm$^2$ sec | Y2L A6 | Y2L A5 | Yemilab (AMoRE) |
|---|---|---|---|
| **Thermal** | 24.2 ± 1.8 | 14.4 ± 1.5 | **15.1 ± 0.5** |
| **Fast (1~10 MeV)** | 4.2 ± 0.9 | 7.1 ± 1.0 | **3.4 ± 0.4** |
| **Total** | 67.2 ± 2.2 | 44.6 ± 6.6 | **40.1 ± 1.0** |

- **Yemilab : Hundreds of tons Shotcrete**
  - ~ 180 tons on AMoRE cavern
- **Non-shotcrete measurement**
- **Higher Rn level during summer season**

# Rn vs thermal neutron flux

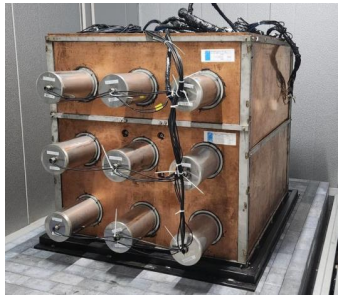
- Mean Rn in 2023 : ~ 1,200 Bq/m$^3$
- Mean Rn in 2024 : ~ 400 Bq/m$^3$
- Keep monitoring continually



**Multi-purpose**

**4 Institutes**
**1 University**
**1 Company (startup)**

**→ 11 research topics**



Institute for Basic Science
(COSINE-100U)

NIMS
($\mu$Gravity)

Institute for Basic Science
(HPGe, Alpha counter)

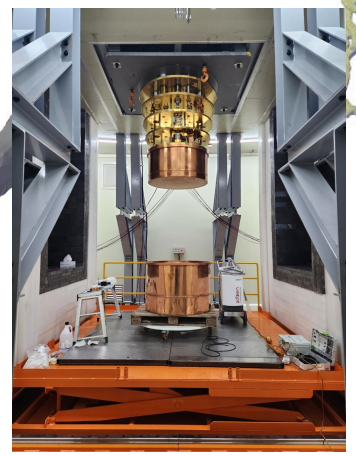
KIGAMS
(Geology)

KAERI
(Env. Radiation)

Kyungpook National University
(KAPAE, $0\nu\beta\beta$ decay R&D)

Institute for Basic Science
($\nu$EYE, future)

Institute for Basic Science
(YUNA@K, future)



Institute for Basic Science
(AMoRE-II)

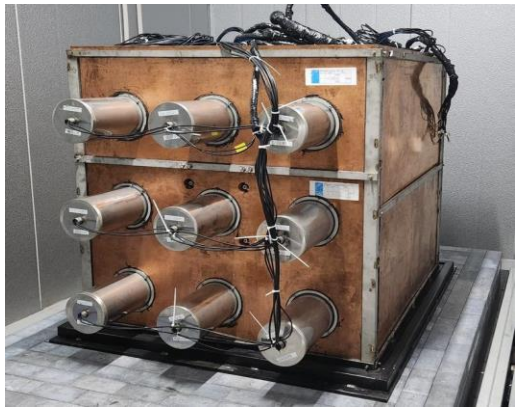
Space Lintech
(Space medicine)

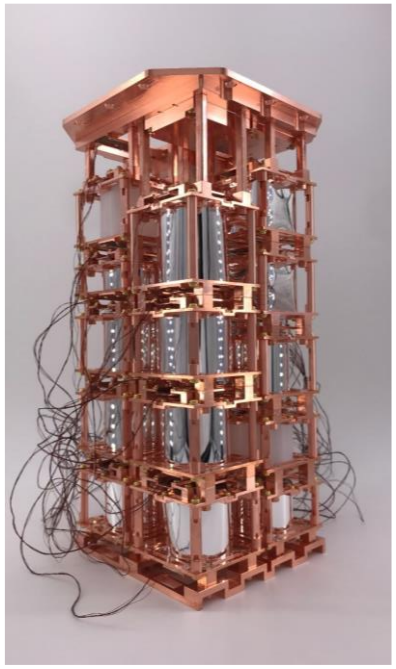
KMA
(Earthquake)

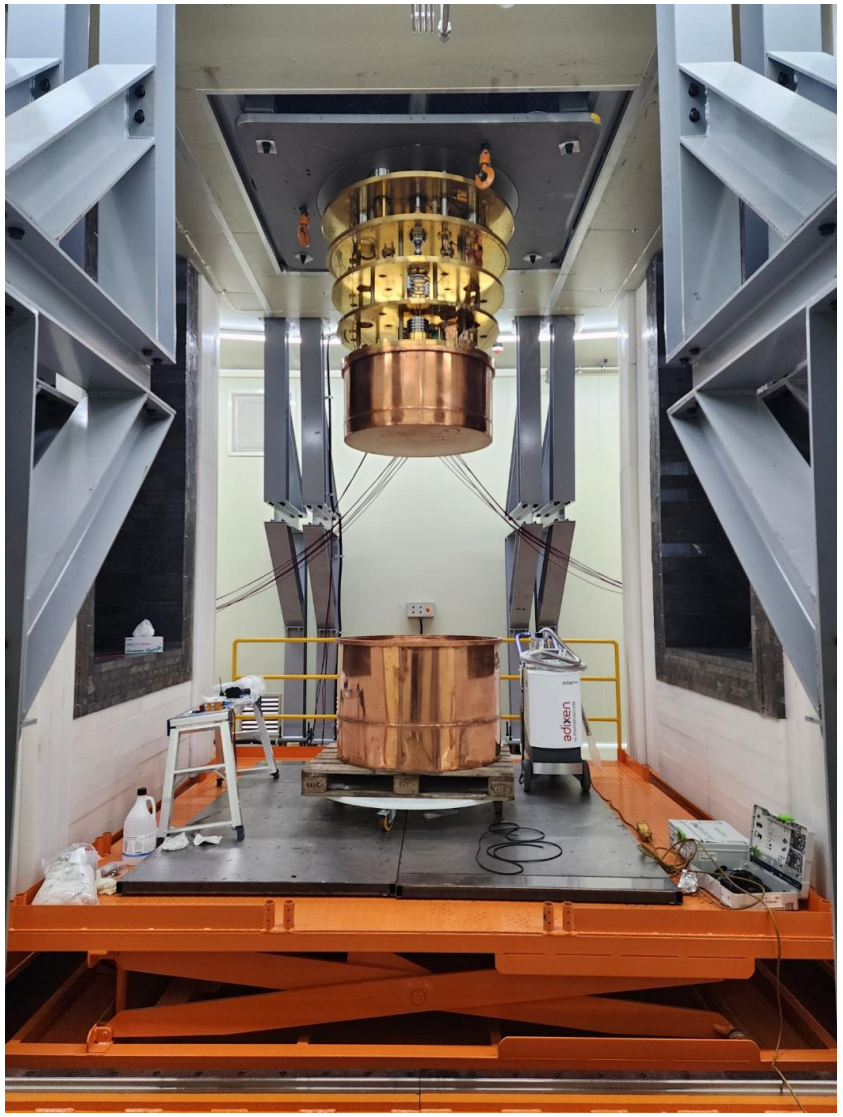
KIGAMS
(Space Planting)

# Nuclear/Particle Physics

CENTER FOR UNDERGROUND PHYSICS







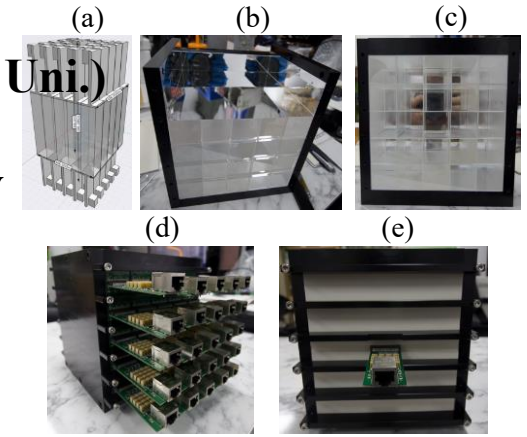
- **WIMP: COSINE-100U @ Yemilab**
  - Lower temperature (-30°C)
  - Experiment will begin in 2025.
- **$0\nu$DBD: AMoRE-II @ Yemilab**
  - Large cryostat is under testing.
  - Experiment will begin in 2026.

# Contribution of CUP @ TAUP

- COSINE
  - Recent results from the COSINE-100 Experiment (by Insoo Lee, Mon. 15:40)
  - Search for Dark Sector particles at a nuclear reactor from the NEON experiment (by Hyunsu Lee, Wed. 15:20)
  - Progress of the COSINE-100U experiment (by Doohyuk Lee, Wed. 16:00)
  - Pulse shape discrimination measurement of CsI(Tl) scintillator with green-extended photocathode PMTs (by Sedong Park, Wed. 17:20)
  - Scintillation characteristics of an undoped CsI crystal with SiPM readout for dark matter detection (by Wonkyung Kim, Wed. 17:40)
  - Status of neutrino-nucleus scattering observations in the NEON experiment (by Seohyun Lee, Wed. 18:00)
- AMoRE
  - AMoRE-II construction status (by Seungcheon Kim, Mon. 16:40)
  - Development of an R-value trigger algorithm for energy threshold reduction (by Wootae Kim, Tues. 17:00)
  - A study of $0\nu$ double electron capture of $^{40}$Ca with the AMoRE-I experiment (by Bijaya Sharma, Tues. 14:00)
  - Updated background simulation and detector design for AMoRE-II (by Eunju Jeon, Wed. 16:00)
  - Search for keV-scale sterile neutrino via $^{3}$H beta decay in LiF crystals (by Kyungrae Woo, Thur. 15:20)
- Radioassay
  - Th and U assessment in high-purity copper for low background applications at CUP (by Olga Gileva, Tues. 14:00)
  - Application of the bateman equation to analyze disequilibrium in $^{232}$Th and $^{238}$U chains in low background detector materials (by Eunkyung Lee, Tues. 14:40)
- Posters
  - Background modeling of AMoRE-I (by Binod Bhandari)
  - Low-threshold analysis for low-mass WIMP search with COSINE-100 (by Wonkyung Kim)
  - Muon-induced backgrounds in the AMoRE-II underground detector (by Jeewon Seo)

# Nuclear/Particle Physics

**Managed by Dongwoo Jeong (Kyungpook National Uni.)**




Detector in refrigerator (~ -80 ℃)

## Observation of the Positronium(Ps) rare decay

- Triplet ($1^3S_1$) state of Ps (orthoPs, o-Ps)
  - Three photon with life-time 142.05 ns
- Singlet ($1^1S_0$) state of Ps (paraPs, p-Ps)
  - Two photon with life-time 125 ps

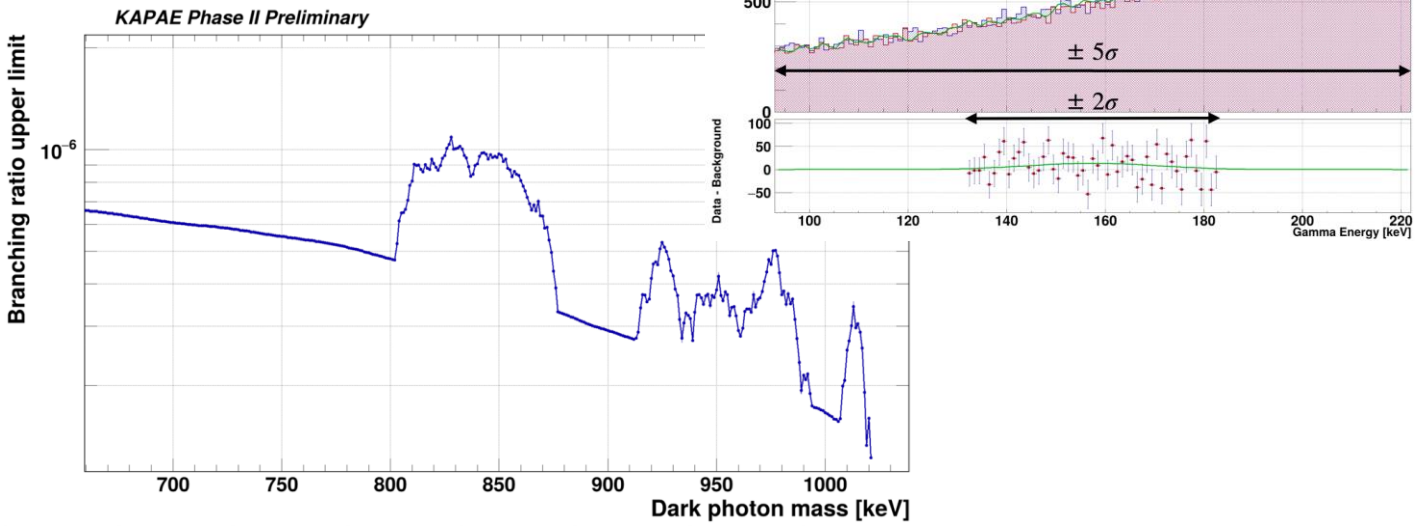
→ Potential new interaction not accommodated in SM

## Motivation of the KAPAE:

### Search for p-Ps → invisible decay

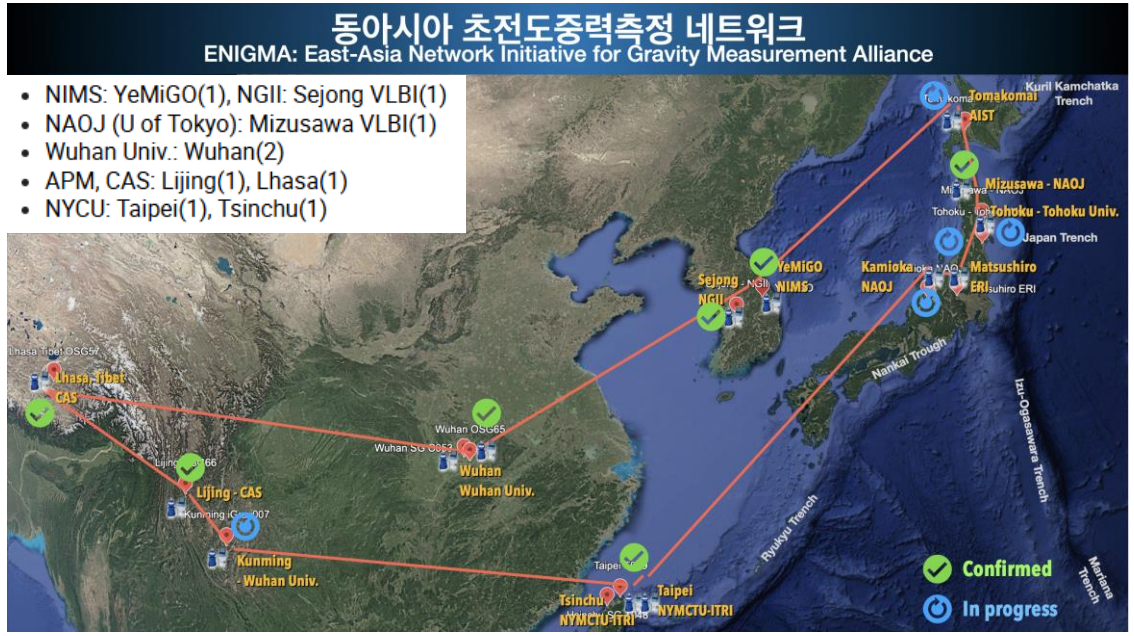
1) Partial invisible decay
   1) p-Ps to gamma + X
   2) Dark photon (new model)
2) Total invisible decay
   1) p-Ps to X
   2) Mirror particle (DM candidate)

Branching ratio upper limit using 24 hours data



# Miscellaneous topics

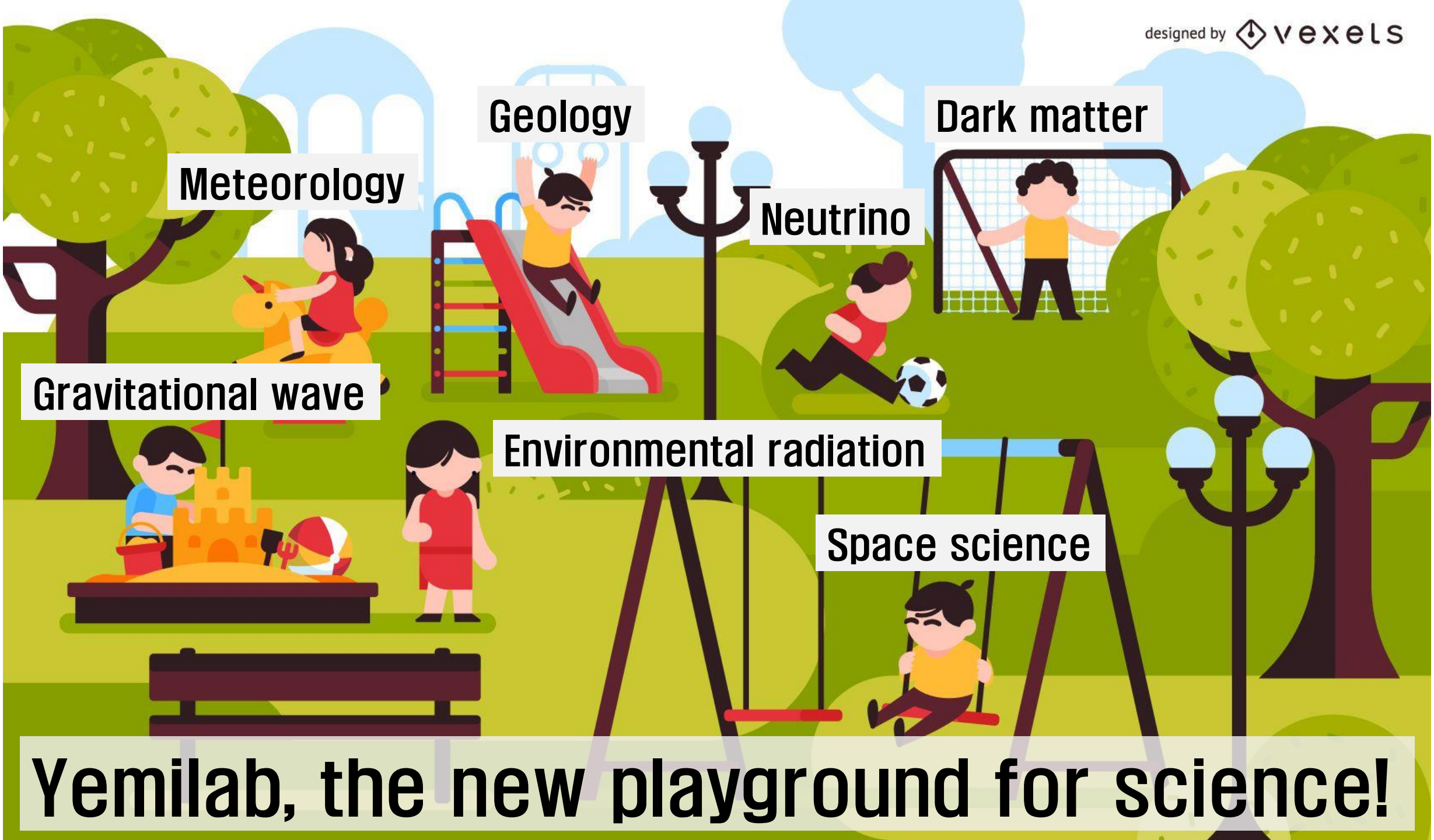
- Geology
  - KMA, KIGAMS
  - Seismic sensor monitoring and calibration
- ENIGMA collaboration
  - NIMS
  - Superconducting gravimeter
  - $\mu$-gravity and earthquake early detection
- Environment radiation screening
  - KAERI
  - Mobius cooled HPGe
  - Robot arm for automatic sample installation
- Space application
  - Space planting (KIGAMS)
  - Space medicine (Space Lintech)
- New topics
  - $\nu$EYE for $\nu$ physics using Large Liquid scintillator
  - YUNA@K for nuclear astrophysics





# Summary

- The Yemilab Operation Center has been started since March 2025.
  - New organization will be helpful to manage the Yemilab properly for researchers.
- The new underground laboratory has been operated for 3 years.
  - Further construction of the infra-structure is still ongoing.
  - Better understanding the condition of the Yemilab.
- Further constructions are planned in 2026.
  - Expending the air circulation (39,000 $m^3$/hr → 100,000 $m^3$/hr)
  - New Radon Reduction System (200 $m^3$/hr)
- Two big experiments @ Yemilab (COSINE and AMoRE)
- Many research topics have been settled down.
  - New topics are under preparation.
  - New proposals are welcome!




# Yemilab, the new playground for science!

# SCINT 2026 (Gyeongju, Korea)

## 18th International Conference on Scintillating Materials and their Applications

🗓️ **Date** : May 25 (Mon) - May 29 (Fri), 2026

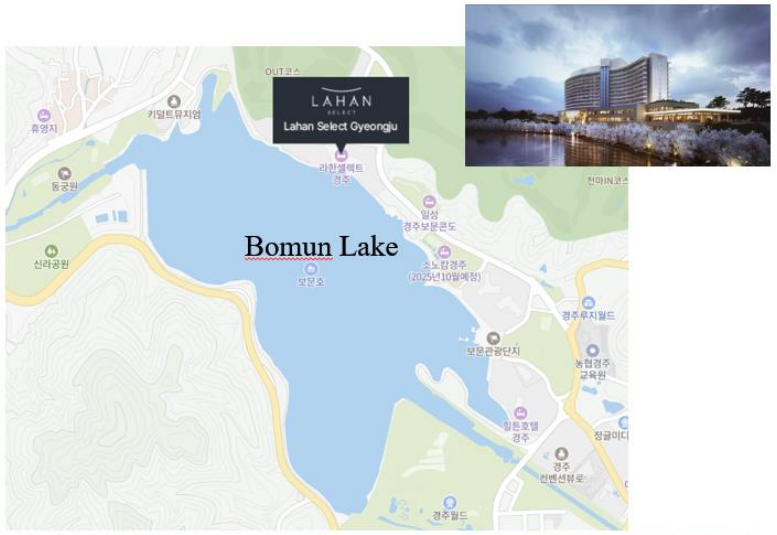
📍 **Venue** : Lahan Select Gyeongju

338, Bomun-ro, Gyeongju-si, Republic of Korea

🌡 **Temperature** : 14°C ~ 25°C (typical in late May, Gyeongju)

🔗 **Website** : https://scint2026.knu.ac.kr/

📬 **Contact** : scint2026@gmail.com




### Gyeongju Historic Areas